

**NATIONAL POLAR-ORBITING
OPERATIONAL ENVIRONMENTAL
SATELLITE SYSTEM (NPOESS)
PREPARATORY PROJECT (NPP)**

**UNIQUE INSTRUMENT INTERFACE
DOCUMENT (UIID)
FOR THE
CROSS-TRACK INFRARED SOUNDER
(CRIS) INSTRUMENT**

April 13, 2000



**GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND**

**INTEGRATED PROGRAM OFFICE
SILVER SPRING, MARYLAND**

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1.0 SCOPE

The purpose of this Unique Instrument Interface Document (UIID) is to allocate key satellite resources and to document certain interface requirements that are unique to the accommodation of the Cross-Track (CrIS) instrument on the NPP satellite.

The UIID documents the NPP satellite resources, such as mass, power, and data rate, specifically allocated to the CrIS instrument in Section 3. Constraints on the integration and test of the instrument and other requirements and procedures are in Section 4. Approved deviations/waivers to interface requirements are in Section 5.

Within the hierarchy of NPP project documentation, the UIID has precedence over the Common Section of the Sensor Requirements Document (CSRD). This UIID, in conjunction with the CSRD, establishes the instrument-to-satellite interface requirements. The CrIS interface control documents establish the details of the electrical, mechanical, thermal, integration and test, and command and data handling (C&DH) interfaces between the CrIS instrument and the NPP satellite.

2.0 APPLICABLE DOCUMENTS

The following documents specify interface and performance assurance requirements:

- a. Common Section of the Sensor Requirements Document (CSRD), Version 2a, 8 March 1999
- b. CrIS Sensor Requirements Document (SRD), Version 2, 8 March 1999

3.0 ALLOCATIONS

The NPP satellite will accommodate the CrIS Instrument. The resources specifically allocated to the instrument are defined in the following paragraphs. All interfaces are redundant and are designated as A and B respectively.

3.1 COMMAND AND DATA HANDLING ALLOCATIONS

The instrument is allocated the Command and Data Handling (C&DH) resources identified in the following paragraphs.

3.1.1 Science Data

3.1.1.1 Average Science Data Rate Allocation - The instrument is allocated an orbit average science data rate after compression, including all CCSDS packetization overhead, of 1.5 Mbps.

3.1.1.2 Peak Science Data Rate Allocation - The instrument is allocated a peak data rate after compression, including all CCSDS packetization overhead, of 1.5 Mbps.

3.1.2 Command and Telemetry Data

3.1.2.1 Interface Ports - The instrument is allocated one (1) Command and Telemetry Data Bus (TBR).

3.1.3 Science-Data Application Process IDS

The instrument is allocated the (TBD) science-data APIDs that lie within the decimal-equivalent range of (TBD) to (TBD), inclusive. The 11-bit binary codes for the minimum and maximum values of this range are as shown.

LSB										MSB
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9	2^{10}

Minimum of Range = (TBD)

LSB										MSB
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9	2^{10}

Maximum of Range = (TBD)

3.1.4 Discrete Interface Allocation

The instrument is allocated the following discrete command and telemetry interfaces:

- Pulse Commands - 6 (TBR),
- Passive Analog Telemetry – 8 (TBR).

3.1.5 Time of Day Pulse Allocation

The instrument is allocated one (1) Time of Day Pulse interface port (TBR).

3.1.6 Instrument Housekeeping Data Rate Allocation

The instrument is allocated a maximum housekeeping data rate, including all CCSDS packetization overhead, of 2 Kbps for all data collected via the Command and Telemetry Data Bus (TBR). This is in addition to the science data rates.

3.1.7 Instrument Discrete (Passive Analog Telemetry) Housekeeping Data Rate Allocation

The instrument is allocated a maximum housekeeping data rate of 50bps for all data collected via the Passive Analog Telemetry Interface.

3.2 POWER ALLOCATIONS

The average and peak operational power allocations include contingencies to be managed by the instrument provider. These allocations are the maximum levels allowed and can never be exceeded. Requirements and guidelines for the contingencies' appropriate usage and depletion rates are described in Appendix A.

3.2.1 Average Operational Power Allocations

Definition: The 1-orbit average power is the average power utilized by an instrument over any one-orbit period commencing with the crossing of the night-to-day terminator.

The NPOESS Not to Exceed (NTE) one-orbit average power allocated to the instrument is 86 watts. The NPP satellite shall accommodate NPP contingency of 9 watts allocated to the instrument.

The instrument shall be supplied with two primary operational power/power return feeds referred to as Primary Feeds A and B.

The instrument shall be supplied with four survival power/power return feeds referred to as Survival Feeds A1, A2, B1, and B2 (TBR).

3.2.2 Peak Operational Power Allocation

The NPOESS Not to Exceed (NTE) peak power allocated to the instrument is 167 watts (TBR).

3.2.3 Survival-Mode Power Allocation

The survival-mode peak power allocated to the instrument is 50 watts (TBR).

3.2.4 Launch-Mode Power Allocation

The launch-mode average power allocated to the instrument is zero (0) watts (TBR).

3.3 MECHANICAL ALLOCATIONS

The instrument shall have the mechanical allocations identified in the following paragraphs.

3.3.1 Mass Properties

The mass allocation includes contingency to be managed by the instrument provider. This allocation may not be exceeded. Appendix A describes the contingency's usage and depletion rate.

3.3.1.1 Mass Allocation - The NPOESS Not to Exceed (NTE) total mass allocated to the instrument is 76 kilograms. The NPP satellite shall accommodate NPP contingency of 8 kilograms allocated to the instrument. This allocation applies only to components supplied by the instrument provider.

3.3.1.2 Mass Expendables - The instrument, while on-orbit, shall not expel any mass.

3.3.2 Volume and Fields-of-View Allocations

The CrIS fields of views are generic, and provided for the purposes of this document only.

3.3.2.1 Launch Volume Allocation - The instrument is allocated the launch volume as shown in Figure 3-1 (TBR).

3.3.2.2 Operational Volume Allocation - The instrument is allocated the operational volume as shown in Figure 3-2 (TBR).

3.3.2.3 Radiometric Fields-of-View Allocations - The instrument is allocated the radiometric fields-of-view as shown in Figure 3-3 (TBR).

3.3.2.4 Detector-Cooling Field-of-View Allocation - The instrument is allocated the detector-cooling field-of-view as shown in Figure 3-4 (TBR).

3.3.3 Instrument Mounting

The instrument shall be attached to the NPP satellite structure with a four-point mount.

3.4 POINTING ALLOCATIONS

Instrument pointing requirements and the instrument's allocation of these requirements are identified in Tables 3-1 and 3-2.

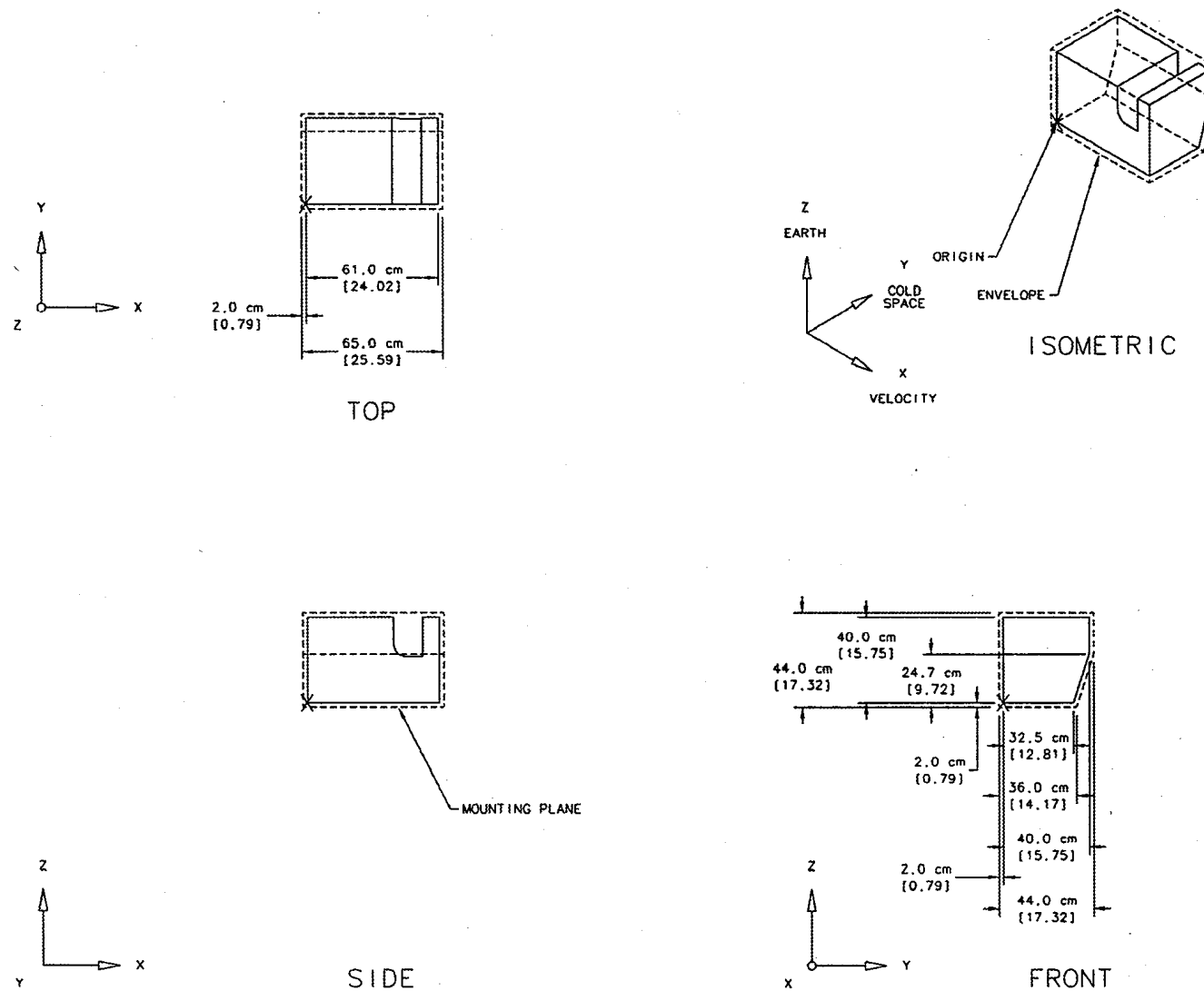


Figure 3-1. CrIS Launch Volume Allocation (TBR)

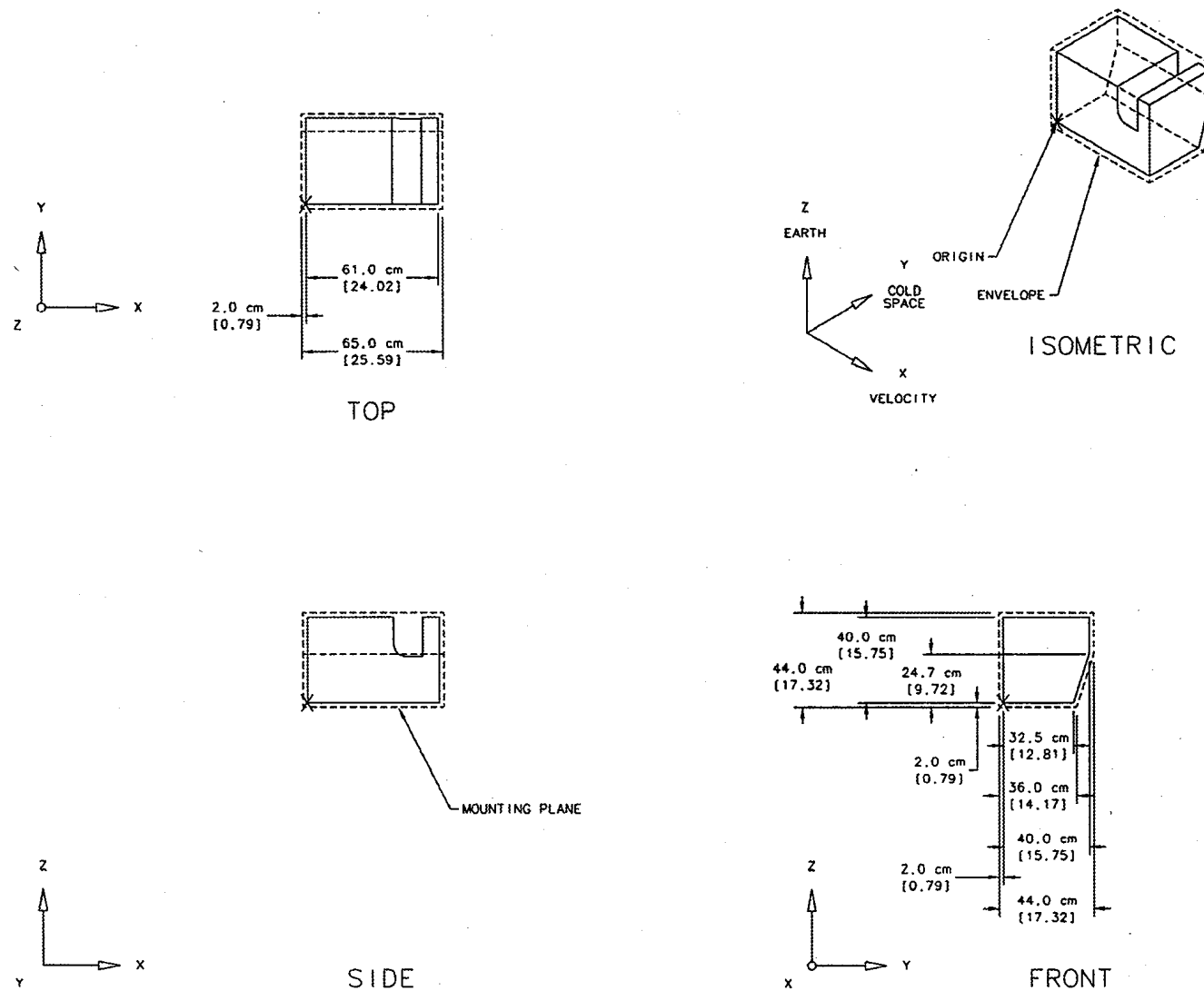


Figure 3-2. CrIS Operational Volume Allocation (TBR)

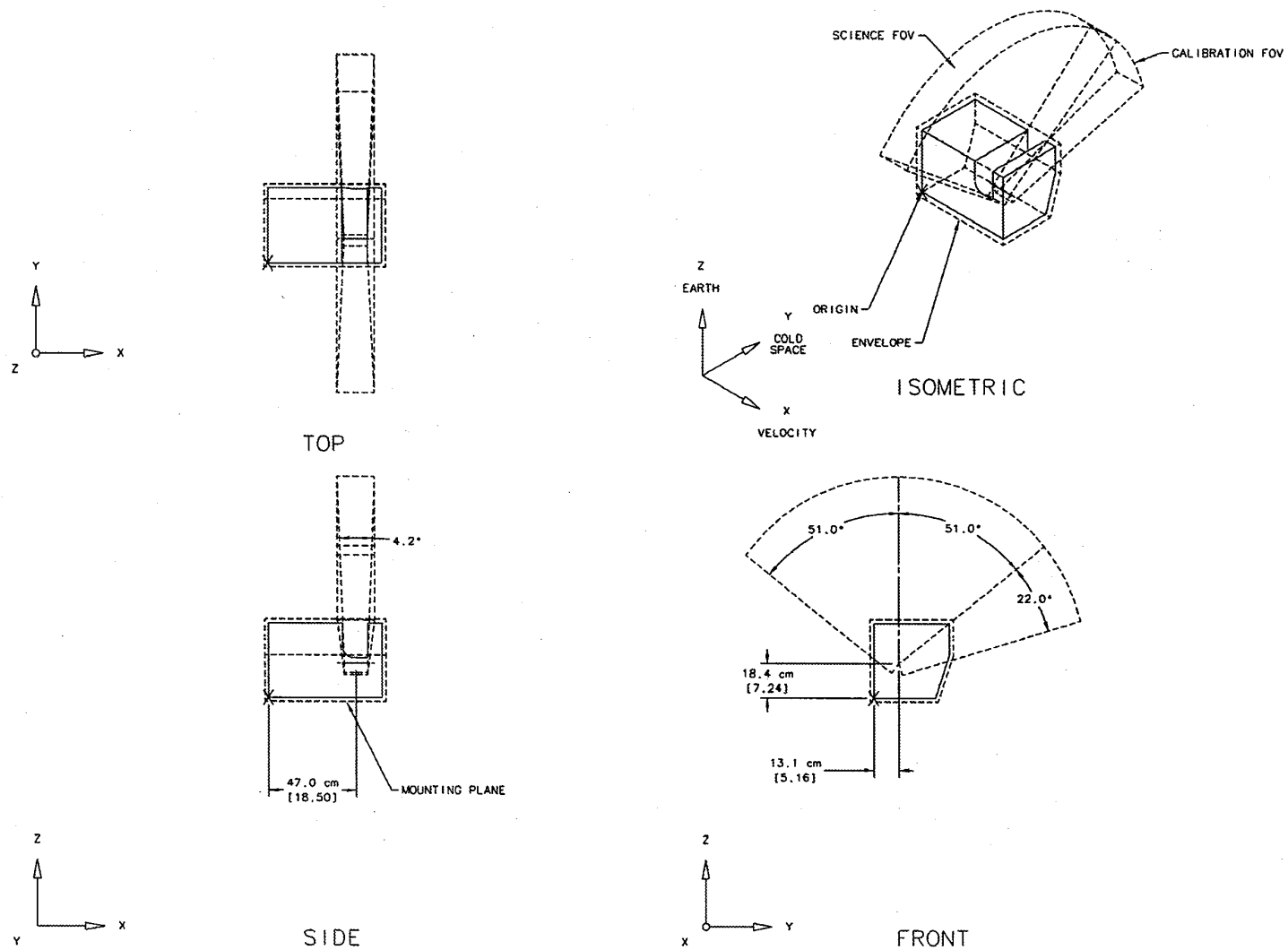


Figure 3-3. CrIS Radiometric Field-of-View Allocation (TBR)

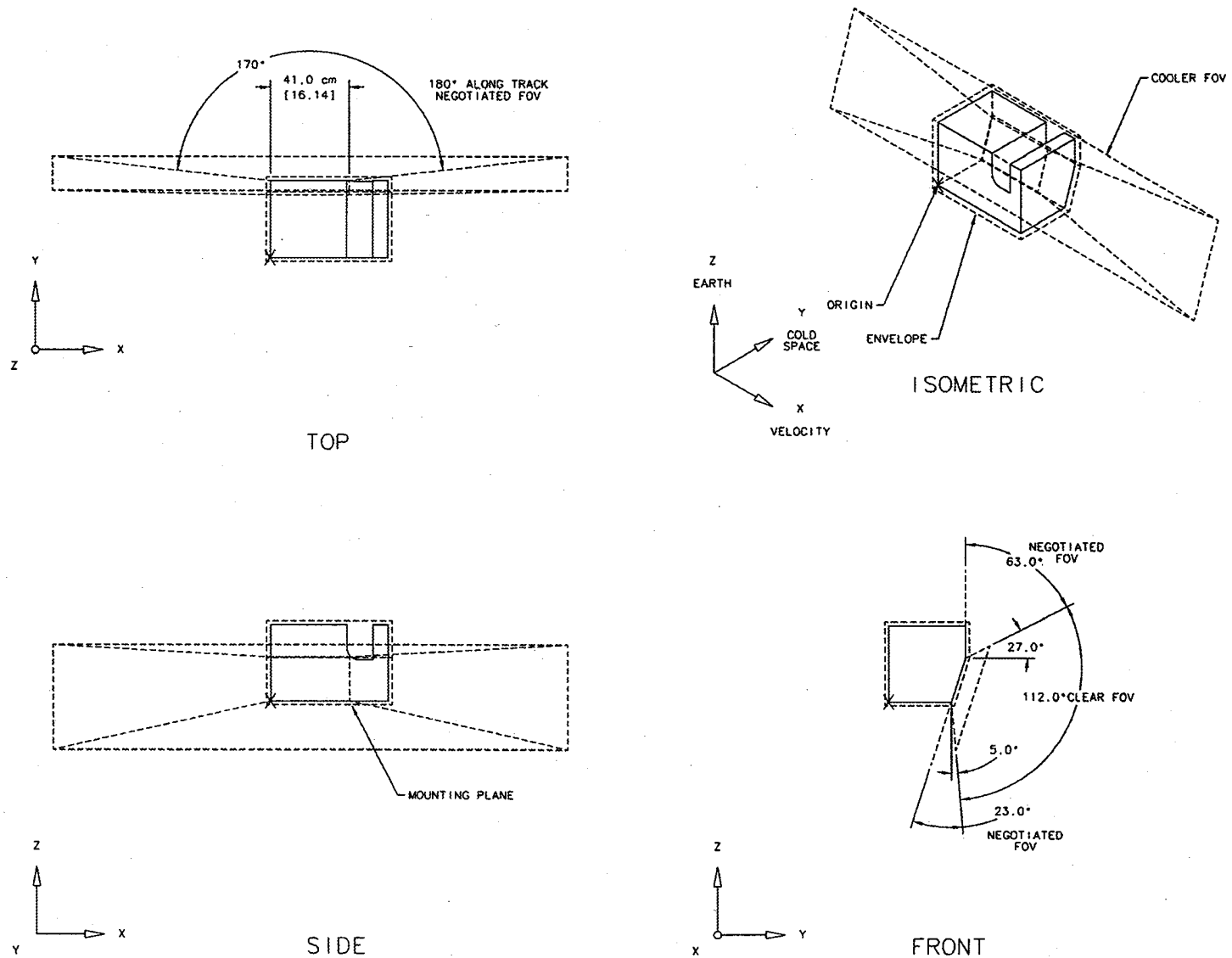


Figure 3-4. CrIS Detector-Cooling Field-of-View Allocation (TBR)

Table 3-1
CrIS Mapping Uncertainty, Pointing, and Position Requirements and Allocations (Table is TBD)

Mapping Uncertainty (Nadir)	Knowledge (m, 1 σ)
Mapping Uncertainty ^{5,6} at Nadir	≤ 5
On-Orbit Position Knowledge Requirement	Knowledge (m, 3 σ)
On-Orbit Position Knowledge ⁶ (Post-Processed)	75

CrIS Pointing Requirement and Allocation

Allocations	Control Accuracy ² (arc-sec, 3 σ , per axis)	Knowledge ² (arc-sec, 3 σ , per axis)
Pointing Requirement: Instrument boresight points toward the Earth frame of reference ¹	1127	217
Unallocated Margin (arithmetically subtracted from the pointing requirement)	TBD	TBD
Instrument Allocation: Instrument boresight-to-mounting interface ^{3,4}	664	199
Satellite Allocation: Mounting interface-to-Earth frame of reference ^{3,4}	911	86

Notes

1. The axes of the coordinate system are defined as follows. The z-axis is from the satellite's center-of-mass and points toward the center of an Earth-centered reference frame. The y-axis is the cross product of the z-axis and the instantaneous velocity vector. The x-axis is perpendicular to both the y-axis and z-axis to complete the right-hand coordinate system.
2. Control accuracy and knowledge are expressed as zero-to-peak variations.
3. Instrument and satellite allocations for control accuracy and knowledge include pointing errors due to static and dynamic error sources.
4. The instrument allocation is root-sum-squared with the satellite allocation to meet the pointing requirement less the unallocated margin.
5. Pointing and Position Knowledge values are Root Sum Squared (assuming 833 km orbit).
6. Position Knowledge values are in X-Y direction. Geolocation Knowledge (circular) value is the RSS of the Geolocation Knowledge values in the X-Y direction.

Definitions - The Spacecraft's pointing requirements are divided into three distinct categories: pointing knowledge, pointing accuracy, and pointing stability/jitter. Figure below, illustrates graphically the definitions for each aforementioned category.

Pointing Knowledge - the accuracy of the determination of the actual pointing direction of a given axis of a selected reference frame. Pointing knowledge can refer to a real-time (on-board) determination or a post-processed (after-the-fact) determination. Requirements and performance discussed herein are real-time.

Pointing Control Accuracy - the angle between the actual pointing direction and the desired pointing direction of a selected reference frame about a given axis.

Pointing Stability - the peak-to-peak variation of the actual pointing direction over relatively long time intervals, per axis.

Pointing Jitter - the peak-to-peak variation of the actual pointing direction over relatively short time intervals, per axis.

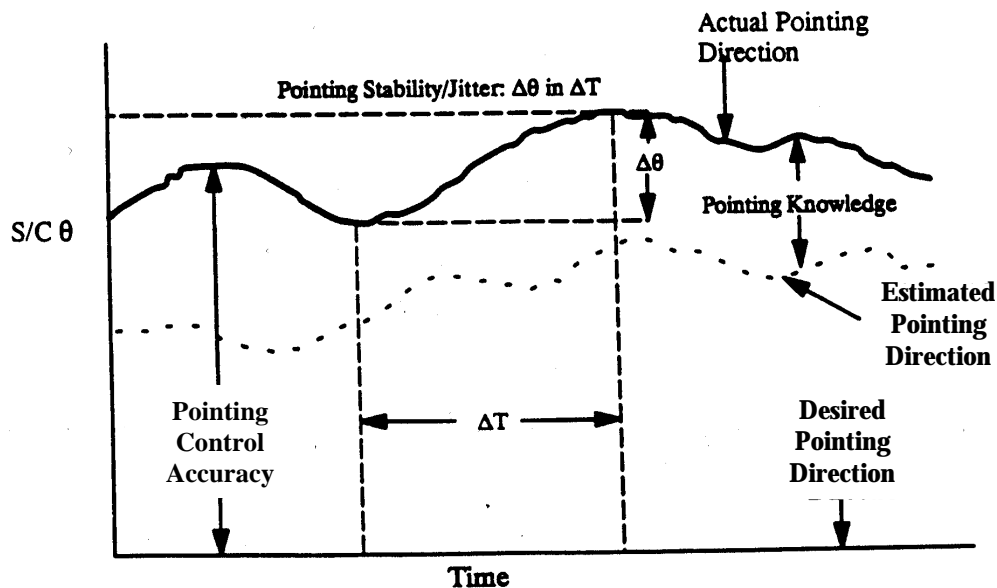


Figure 3-4 Pointing Requirement Definition

Table 3-2
CrIS Pointing Stability Requirements and Allocations (Table is TBD)

Allocations	arc-sec, 3σ , per Δt (peak-to-peak)		
	Roll	Pitch	Yaw
Pointing Stability: Instrument boresight points toward the Earth frame of reference ¹	TBD	TBD	TBD
Unallocated Margin (arithmetically subtracted from the pointing requirement)	TBD	TBD	TBD
Instrument Allocation: Instrument boresight-to-mounting interface ²	TBD	TBD	TBD
Satellite Allocation: Mounting interface-to-Earth frame of reference	TBD	TBD	TBD

Notes

1. The axes of the coordinate system are defined as follows. The z-axis is from the satellite's center-of-mass and points toward the center of the Earth-centered reference frame. The y-axis is the cross product of the z-axis and the instantaneous velocity vector. The x-axis is perpendicular to both the y-axis and the z-axis to complete the right-hand coordinate system.
2. The instrument allocation of the stability requirement includes effects of disturbance sources such as thermal distortion internal to the instrument, instrument pointing system performance, internal-to-instrument disturbances, (e.g., scan mechanisms). The instrument allocation is arithmetically added with the satellite bus allocation and the unallocated margin to meet the pointing stability requirements.

4.0 CONSTRAINTS

In order to ensure proper instrument performance or to prevent possible instrument damage, the following constraints are imposed by the CrIS instrument developer on satellite integration and test activities, including launch, activation, and operational.

No constraints have been identified.

5.0 DEVIATIONS/WAIVERS

This section specifically identifies CrIS requirements that deviate from those defined in the CSRD, latest revision, or the Instrument document, latest revision. Paragraph titles and numbers, identified in parentheses, are those from the CSRD or the CrIS SRD.

5.1 CSRD DEVIATIONS/WAIVERS

No deviations or waivers have been identified.

5.2 CrIS SRD DEVIATIONS/WAIVERS

No deviations or waivers have been identified.

Appendix A

Contingency Management Requirements

Available satellite resources are limited by many factors, including launch vehicle fairing volume which constrains satellite configuration and component sizing, launch vehicle lift capacity which limits total satellite mass, and solar array sizing which constrains total power resources. An indirect volume limitation is the total unobstructed surface area available for radiative thermal dissipation. The design of the satellite represents a system solution assimilating all imposed constraints. It is critically important that all elements of the satellite, including the instruments, be designed and delivered within established resource allocations.

Satellite resources provided for each instrument, such as mass, power, and data rate, are allocated in the Unique Instrument Interface Document (UIID). The satellite design must provide and accommodate the resources allocated to each instrument, and the instrument design must not exceed the resources allocated to the instrument. Establishment of firm resource allocations for all instruments is critical to the orderly development and design of satellite subsystems and components to support instrument resource needs.

Accordingly, resource allocations established within this UIID include contingency margins over the baseline resource estimate provided for the instrument. The instrument baseline estimates plus assigned contingencies represent the total allocations available to the instrument. No additional contingency is held by the NPP Project Office to cover instrument growth beyond the total allocation. The management of the bulk of the contingency is delegated to the instrument development teams. However, distributing, dispensing, or liening instrument contingency is subject to the following constraints:

1. It must be reemphasized that the UIID allocations represent the total resources available to the instrument through delivery and launch. There is no assurance that instrument requirements beyond these allocations can be met by the NPP Project.
2. Baseline contingency is defined as the difference between the total resource allocation and the baseline estimate. For the purposes of this document, the baseline estimate is dated and remains fixed for the life of this document. Baseline estimates are listed in Table A-1. The effective date of the baseline estimate is the date this document is signed by the NPP Project Manager.

Remaining contingency is defined as the difference between the total resource allocation and the current estimate of resources. Reporting of the current estimate is defined in paragraph 5 below.

3. Apportionment of any of the final 5% of the contingency requires approval from the NPP Project Office. Although pre-allocated to the instrument, the final 5% represents a critical contingency level and the project must participate in any decision to release any of this contingency.

4. Contingency should be properly retained throughout the instrument development cycle to ensure adequate margin for subsequent instrument development phases. Tables A-2 and A-3 list the percent baseline contingency and the percent remaining contingency guidelines at the PDR, the CDR, and the Delivery milestones.
5. A summary resource table, Table A-4, shall be provided with the instrument Monthly Technical Progress Report submitted by the instrument developer. The monthly resource summary shall document current estimate and balance of contingency. Allotments of contingency during the month shall be itemized with a brief description of the decision rationale.
6. Project approval is required on any contingency dispensation exceeding the following criteria:
 - a. Any distribution of the last 5%
 - b. Any single distribution > 5%
 - c. Any distribution, which causes PDR, CDR, and Delivery guidelines to be exceeded.
7. Analytical structural and thermal models of the instrument shall accurately reflect the latest instrument resources estimates. Provisions shall also be made to run these models at the total allocation limits. A description of the distribution of the unused contingency within the models shall be provided to allow proper interpretation of the model results. This is required to ensure consistency with the integrated satellite analyses, which account for instrument resource margins.

Table A-1
Baseline CrIS Resources Estimates
[Contingency shown in brackets]

Power (w)			Mass (kg)
Average		Peak	
2-orbit	1-orbit		
73 (30)	73 (30)	144 (31)	65 (26)

Table A-2
CrIS Power Contingency

Milestones	Remaining Contingency ² (percent)		
	Average (percent)		Peak (percent)
	2-orbit	1-orbit	
Baseline ¹	41	41	21
PDR	≥20	≥20	≥20
CDR	≥10	≥10	≥10
Delivery	≥5	≥5	≥5

Table A-3
CrIS Mass Contingency

Milestones	Remaining Contingency ² (percent)
Baseline ¹	40
PDR	≥15
CDR	≥10
Delivery	≥5

Notes for Tables A-2 and A-3

- Baseline Contingency (percent) = $\frac{\text{Allocation} - \text{Baseline Estimate}}{\text{Baseline Estimate}} \times 100$
- Remaining Contingency (percent) = $\frac{\text{Allocation} - \text{Current Estimate}}{\text{Baseline Estimate}} \times 100$

Table A-4
CrIS Resource Summary (Form)

RESOURCE SUMMARY

(INSTRUMENT) (DATE)	Weight (Kg)	1-Orbit Avg. Power (w)	2-Orbit Avg. Power (w)	Peak Power (w)	Avg. Data Rate (Kbps)	Peak Data Rate (Kbps)
ALLOCATION CURRENT ESTIMATE PREVIOUS ESTIMATE CHANGE FROM LAST REPORT MARGIN TO ALLOCATION						

WEIGHT

CLASS (PERCENT)	
ESTIMATED	
CALCULATED (layouts and drawings)	
FLIGHT MEASURED	

POWER

CLASS (PERCENT)	1-Orbit Avg.	2-Orbit Avg.	Peak
ESTIMATED			
MEASURED			

POINTING BUDGET SUMMARY

	Accuracy (arc-sec, 3 σ per axis) zero-to-peak)	Knowledge (arc-sec, 3 σ per axis) (zero-to-peak)	Stability [arc-sec, 3 σ per Δt (peak-to-peak)]		
			Roll	Pitch	Yaw
ALLOCATION CURRENT ESTIMATE PREVIOUS ESTIMATE CHANGE FROM LAST REPORT MARGIN TO ALLOCATION (arithmetically subtracted from allocation)					

Appendix B

Acronyms

APID	Application Process Identification
BDU	Bus Data Unit
bps	bits per second
C&DH	Command and Data Handling
CCR	Configuration Change Request
CCSDS	Consultative Committee for Space Data Systems
CDR	Critical Design Review
CrIS	Cross-Track Infrared Sounder
CSRD	Common Section of the Sensor Requirements Document
FOV	Field-of-View
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
ID	Identification
kg	kilograms
LSB	Least Significant Bit
MAR	Mission Assurance Requirements
Mbps	Megabits per second
mm	millimeter
MSB	Most Significant Bit
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NPP	NPOESS Preparatory Project
NPOESS	National Polar-Orbiting Operational Environmental Satellite System
PDR	Preliminary Design Review
RSS	Root Sum Square
TBD	To Be Determined
TBR	To Be Resolved
TBS	To Be Supplied
UIID	Unique Instrument Interface Document
W	Watt